MAKING CARBONIC ACID

Objectives:

Students will:

- investigate the concepts of pH, acidity, and alkalinity,
- demonstrate how carbonic acid is formed, and
- describe how carbonic acid can dissolve limestone to create caves.

SUB SUB

Materials:

- White litmus paper
- Small cups, one per student
- Straws, one per student (coffee stirrers will work)
- Soda water or soda pop, preferably clear
- Flat soda water or soda pop
- Vinegar
- Distilled water
- Baking soda



Procedure:

- 1. Ask the students, "What is an acid?" Discuss the concept of acidity. What acids are the students familiar with? Discuss citric acid, stomach acids, battery acids, etc. Discuss what makes acids acidic (many hydrogen ions in solution). What are characteristics of most acids?
- 2. What are bases? Discuss alkalinity. What makes bases basic? (Many hydroxides in solution.) Draw the pH scale on the board, from 0 to 14. Refer to the attached chart to associate pH values with hydrogen ions with familiar household substances. This should help the students get better control of the concepts. Discuss the meaning of the numbers in the scale. (1 x 10⁻⁷ hydrogen ions in solution = pH 7, where the parts of H+ are 0.0000001 and for a pH of 2 the parts of H+ are 0.01 making it more acidic, etc.) The lower the pH, the higher the acidity. 7 is neutral. (Acid is low 1-7, base is high 7-14, just like a before b in the alphabet.) Decide what information your students would benefit the most from. Younger students do not need to be introduced to the ions in solution information, etc.
- 3. Give each student a small cup of vinegar, a small cup of distilled water, a small cup of baking soda/water solution, and 3 pieces of white litmus paper. The litmus paper will turn red in an acid, blue in a base, and remain white in a neutral solution.
- 4. Have the students dip a piece of litmus paper in each cup and quickly remove it. The color change should be instantaneous.
- 5. Next, discuss how water can become acidic. What chemical transformation needs to take place? (The hydrogens need to dissociate from the oxygen.) What happens when water mixes with carbon dioxide? Write the equation on the board

$$H_2O + CO_2 \rightarrow H_2CO_3$$
 (carbonic acid)

The hydrogens are now bonded to carbon instead of oxygen.

6. Give each student a straw or coffee stirrer and another piece of litmus paper. Have them blow bubbles into their cup of distilled water for approximately one minute, then test

- with litmus paper. Did the paper turn red? Why? (Testing the water needs to happen while the students are blowing into the water or immediately after the student stops.)
- 7. Why is soda pop fizzy? Soda pop is mostly carbonated water water is mixed with carbon dioxide under pressure. Give each student a small cup of soda, and have them test for acidity with a fresh piece of litmus paper. Does it turn red? Is it more red than the paper from step #6?
- 8. What happens when soda goes flat? Give each student a small cup of flat soda, and have them test it with litmus paper. What color is it? Why?
- 9. How might water turn to carbonic acid in nature? Discuss the conversion of water to carbonic acid as it seeps through soil. Water from snow melt or rain will pick up carbon dioxide (from decaying plants and other organic material) as it travels through the soil.
- 10. Where does the carbonic acid go once it passes through the soil? It will hit the bedrock. If this bedrock is limestone (or another carbonate rock), the carbonic acid will slowly dissolve it. Is the water in the cave acidic today? Why or why not? Think about the degassing process.
- 11. Next, complete the "Make a Cave" activity.

Hydrogen	pН	Familiar substance
ions		
$1x10^{0}$	0	Hydrochloric Acid at 4%
$1x10^{-1}$	1	Stomach Acid
$1x10^{-2}$	2	Lemon Juice
$1x10^{-3}$	3	Vinegar
$1x10^{-4}$	4	Soda Pop
$1x10^{-5}$	5	Rainwater
$1x10^{-6}$	6	Milk
$1x10^{-7}$	7	Pure Water
$1x10^{-8}$	8	Egg Whites
1x10 ⁻⁹	9	Baking soda
$1x10^{-10}$	10	Ammonia
$1x10^{-11}$	11	
1x10 ⁻¹²	12	Drano (Copyright)
$1x10^{-13}$	13	NaOH at 4% Sodium Hydroxide
$1x10^{-14}$	14	

